MODAL ANALYSIS FOR THE REGIONALIZATION OF LOCAL LANDFORM DATA IN CENTRAL AMAZÔNIA SEDIMENTARY RELIEF

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ABSTRACT

This paper describes a procedure to regionalize local landform information derived from SRTM for broad scale studies of the central Amazônia relief. Modal landforms of mapping units were assigned to terrain segments based on elevation data. Top landforms prevailed among first mode classes, and a second mode was then assigned, considering only the less frequent landforms related to fluvial incisions. The combinations of first and second modes were evaluated through detailed examinations of local DEM and landforms together with the available geological data. After regrouping the most associate classes, the final modal landform combination map showed the effectiveness of the method for regionalization of landform data.

Key words ð *SRTM, DEM, landform, Amazônia.*

1. INTRODUCTION

In its large extension, the sedimetary domain of central Amazônia presents a uniformly gentle relief, with very low features. Most of the regional variation in elevation is related to the centripetal dip of the sedimentary basin, a general trend affected by uplifts and subsidences, related to stepwise faults and tiltings (often combined) and occasional dome-like features. Short-range altimetric variations in the sedimentary domain of central Amazonia are characterized by sharp elevation contrasts between terraces neighboring drainage features. In general, the main variations of local geomorphometric data depict only the arrangement of major features, besides enhancing the fluvial network and scarps. For the specific purpose of terrain characterization, most of the local data is useless in such environment, except for providing elements which could be explored in the context of regional relief patterns. The assignment of averaged values (or other measure from the distribution) into terrain units was shown an effective procedure to regionalize local data for slope, profile curvature and relative relief in this area [1]. And, for the sedimentary domain, patches resulting from elevation segmentation conveniently match the concept of unitary deposits, an optimum terrain unit for this case. Despite the reduction of range and variance relative to originally local data, the regionalized variations were more consistently arranged into recognized terrain features.

Landform is a qualitative terrain descriptor defined by the nine combinations of the basic three classes of profile curvature (convex, concave and rectilinear) and those of the plan curvature (convergent, divergent and neutral) (Figure 1). The regionalization of such a qualitative terrain descriptor would enable its use as input for relief characterization in the challenging conditions of central Amazônia sedimentary domain.

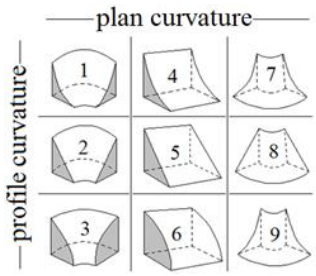

Figure 1. Landforms classes and their identifiers.

2. MATERIAL AND METHODS

The study area (1,477,616 km^2) covers mostly the sedimentary domain of central Amazônia (Figure 1). Data was taken from Topodata [2], a full-coverage database for Brazilian territory, which includes Digital Elevation Model (DEM) and derived local geomorphometric data. The study area was covered by 80 quads (1^o latitude x 1.5^o longitude each), where the corresponding data layers of elevation and landform were concatenated and subsampled to 3 arc-second resolution into contiguous layers of 14 400 columns and 12 000 rows. All data operations and analyses were accomplished with TerrSet [3] facilities. Graphic outputs as maps and transects were produced with Global Mapper [4].

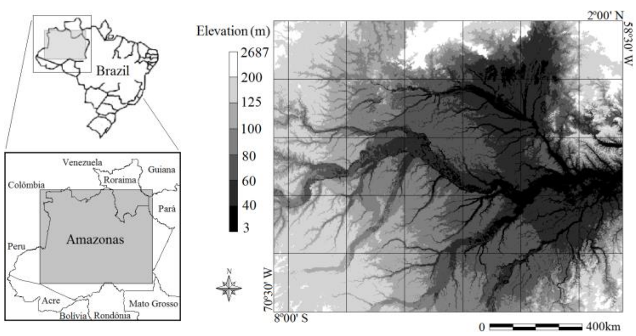

Figure 2. Localization and general hypsometry of study area.

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Data relative to the Brazilian and Guiana Shields were excluded (masked) from all analysis to avoid segment levels to undesirably spread up to the maximum elevation. These areas were delineated based on local height and relative relief. Floodplain areas were also kept aside since it is not the targeted environment. The delineation of floodplains was based on stratified levels of elevation with visual control on the prevailing feature type (erosion or depositional), in procedures to be detailed in a future paper.

Terrain patches produced through segmentation of elevation data were regrouped combining several techniques to improve the coalescence of segments into useful mapping units [1]. The regionalization level, established by several parameters of the patching procedures, was selected through visual examinations to assure the inclusion of small and shallower drainage networks together with the relatively undisturbed portions of the interfluves.

The assignment of landform (first) mode was directly obtained with query operations over landform local data relative to the mapping units. A second mode was obtained by comparing the frequencies of the targeted landform classes in each mapping unit. The combinations of first and second modes were directly obtained through cross tabulation.

3. RESULTS

Landforms classes of 1, 2, 8 and 9 (see Figure 1) were the most evident types among the first mode. The resulting map showed classes 1 and 9 to occur in the same areas, depicting the most intensely dissected terrain at the western part of the study area. The spatial arrangement and territorial distribution suggested the convenience of putting these classes together into a single class. Classes 2 and 8 were the two dominant classes, due to the prevalence of the top relief, of relatively undisturbed terrain, which alternates between one landform and the other. However, mapping units of same modal landforms coalesced into regions, in an evidence of the regional characterization of the terrain. Classes from 3 to 7 occurred in a much lower frequency yet in the local distribution, and thus reached mode for virtually no terrain unit. When masking classes 1, 2 8 and 9, the second mode resulted in landform classes 5 and 7, only, and the map was considered at least confusing, when compared to known features, if not useless in its two classes. The analysis with the remnant classes (3, 4 and 6) was more useful, since the results were self-coherent and harmonic to the first mode results. Detailed examinations showed second mode landforms to be related to the tridimensional configuration of fluvial incisions, in complement to the characterization of the top relief by the first mode.

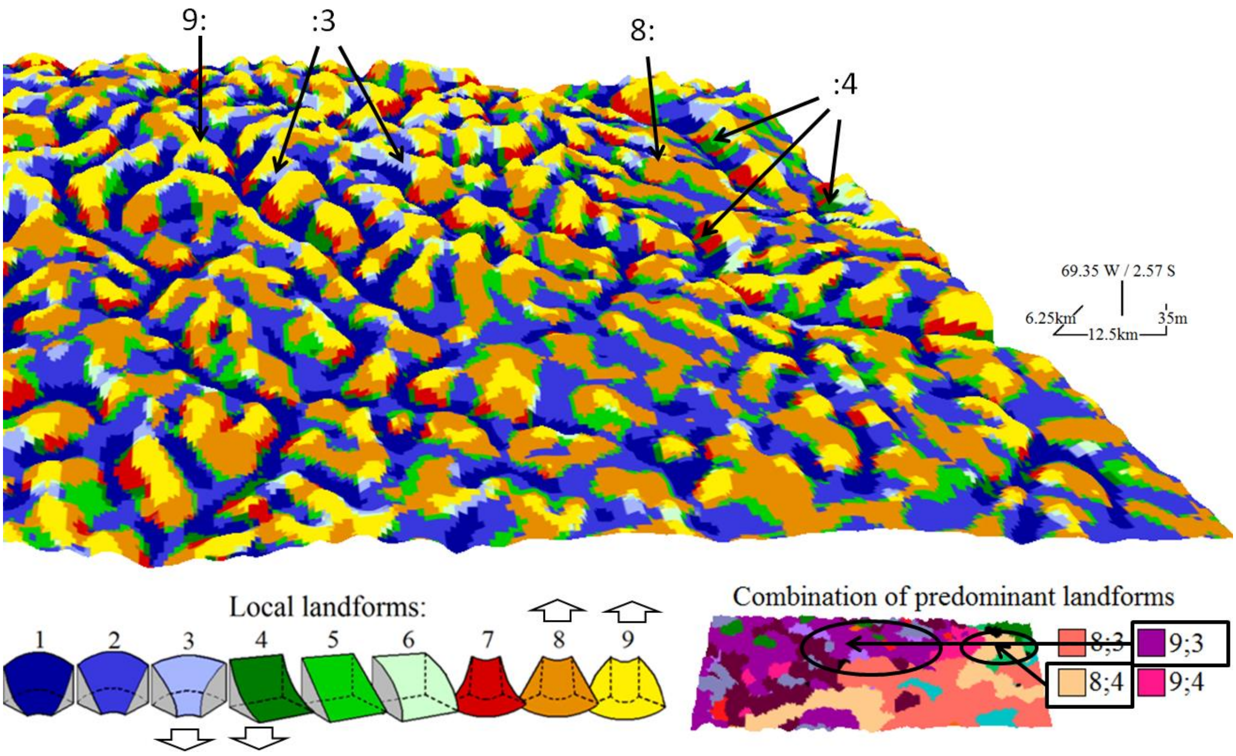

Figure 3. Example of landform mode combinations: first modes (8: and 9:) were related to top relief (arrows up in the local landform legend) while second modes (:4 and :3) were related to fluvial incisions (arrows down).

The verifications helped to resolve minor classes and the less frequent class combinations, by joining different mode results to the main prevalent classes to define a useful and complete legend for all cases. In this synthesis, first modes were joined into three groups. In decreasing order of area, the first group (2+3+5) was subdivided according to the second modes, 4, 6 and 7, while the second group (8+9) was subdivided by landforms 5, 9 and 1 in the second mode. The third group was defined yet by the first mode (landforms 1+9 in the first mode), with no further subdivision (see map legend of Figure 4).

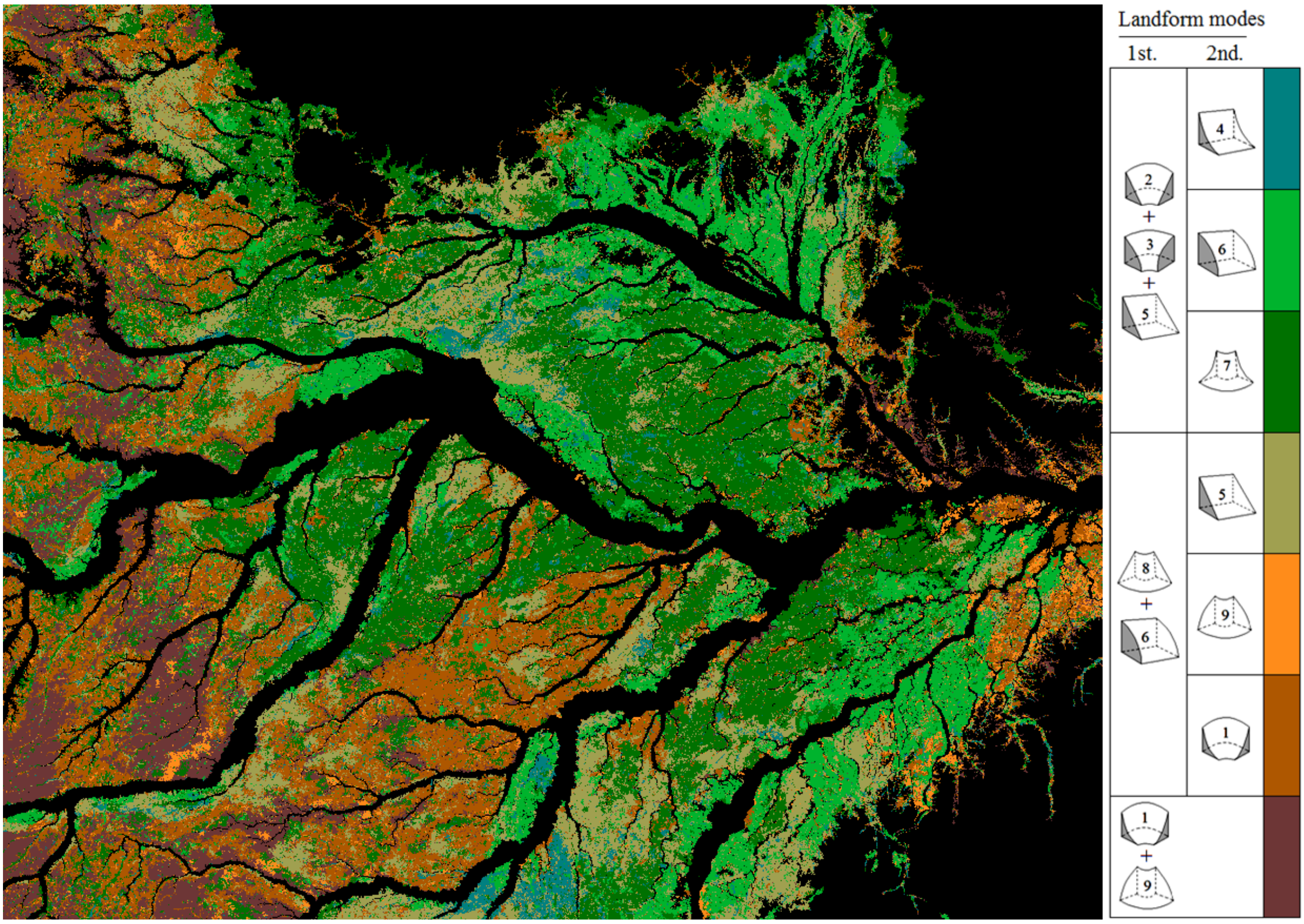

Figure 4. Regional landform combinations of the study area. Areas in black are the floodplains and shields.

4. DISCUSSION

Landform type modes were shown to present regional distribution as areas of similar combinations tend to coalesce into wide and contiguous regions. This was particularly interesting for the major division given by the first modes, where the modal landforms could be related to the top and thus prevailing relief. Less frequent on the tops, landforms 1 and 9 correspond to the most disturbed condition considering the expectation of sedimentary packs being more rectilinear and neutral in its curvatures. Fortunately, those landforms were spatially related, and both could be assigned in an area correspondingly affected by intense fluvial dissection, in a region were an old sedimentary formation is recognized (Solimões formation).

In the other hand, landform 5, which represents the most undisturbed situation (rectilinear and neutral), played an ambiguous role in this characterization, presumably due to the independence between its frequency and relief differences. As a rule, divergent landforms were more frequent in top relief than in the fluvial incisions.

A positive observation about the final map (Figure 4) is the centripetal arrangement of landform patterns, which seems corroborate the expected peripheral distribution of older deposits (at west), as discussed earlier, progressing to younger ones at the eastern portion of the study area, near the depocenter, where landform class 2 prevailed.

The occurrence of fluvial-related landforms in the second mode was an unplanned natural consequence of the analysis and the applied methods. However, once observed, this relation could be properly explored in future developments. A possible improvement is analyzing the top landforms separately from the fluvial-influenced ones, by stratifying the analysis of their frequencies in one and in the other environment. Complementary Booleans of the two environments could be constructed based on local geomorphometry to control the inputs and to organize results into separate sets. This could assure the full independence between the characterization of the top relief landforms and the fluvial incisions, possibly reflecting strata-process combinations in the results.

5. CONCLUSIONS

The regionalization of local landform data was developed in an approach consisting of a two-stage mode analysis followed by the combination of both results. The developed approach was successful in depicting regional patterns, although possible improvements could retrospectively be identified for a better and more conceptually found characterization. Three main patterns were defined by the first mode, with landforms and the combination with second mode landforms converging to the establishment of seven final classes. The spatial distribution of landform patterns was coherent with the expectancy around age of the sedimentary deposits, their characteristics, and their relative position in a sedimentary basin. Among agreements and differences relative to available geological maps, we highlight that landform data is only one of the numerous terrain descriptors to potentially support geomorphological or geological mapping of this environment, and is not expected to feed alone the characterization of relief, despite of occasionally prompt correlations.

6. REFERENCES

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